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ABSTRACT

Designed to assist those responsible for designing school and school district computer literacy programs, this paper suggests a practical definition of the term "computer literacy," discusses types of support and skills computer literacy teachers should possess, and offers a scope and sequence model for teaching computer literacy from kindergarten through 12th grade. Under prerequisites for effective computer literacy education, three crucial factors of computer education and planning are identified and discussed in detail: (1) specific statements of goals and objectives; (2) district and local support of computer education; and (3) computer literacy training for teachers. The scope and sequence model categorizes topics and activities as being related either to computer awareness or computer programming and discusses each grade level separately. A chart summarizes the curriculum model, and eight references are listed. (LMM)

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A SCOPE AND SEQUENCE CURRICULUM (K-12) FOR COMPUTER LITERACY

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COMPUTER LITERACY ACROSS THE CURRICULUM:

A SCOPE AND SEQUENCE MODEL

Introduction

In recent years, there has been growing concern over whether U.S. schools are offering their students an education that is competitive with education offered in other countries. We hear that U.S. colleges and universities graduate a relatively small number of engineers each year, and this fact worries those who fear that the U.S. may not long remain competitive on the world market, which grows more technologically oriented each year. Indeed, this is a justifiable concern that has tremendous implications for educators across the country, who are responding by designing and implementing programs for computer literacy education.

One such group of educators concerned with the issue of computer literacy is the Albequerque Public Schools (APS). In its Computer Education Proposal of January, 1983, APS offers the following rationale for its intention to teach computer literacy:

> We are entering an era of high technology. To serve our public well, we must prepare all our students to relate to and use this new technology. We believe that within ten years knowing how to use computers to solve problems will be as important a basic skill as reading.[1]

This well-founded sentiment is becoming commonplace among educators all across the country. Now that it has been widely recognized, the need for computer literacy places demands on schools and districts. The problem is that at this point there is relatively little help for those charged with the responsibility of designing computer literacy programs. This paper attempts to offer such help by first suggesting a practical definition of the term computer literacy, by discussing what types of support and skills teachers of computer literacy should possess, and by offering a scope and sequence model for teaching computer literacy from kindergarten through twelfth grade.

Toward a Definition of Computer Literacy

Given the number of definitions of the term computer literacy that have been posited by experts in the field, it is not at all surprising that educators may feel some confusion when trying to determine what skills and concepts a computer literacy program should develop and enhance. In Computer Literacy: What It Is and How to Do It, the Arizona Department of Education gathers several of these definitions:

> "The ability to function capably in a computer and technology oriented society." (Total Information Education Systems, Minnesota School District, St. Paul)

> "Whatever a person needs to know and do with computers in order to function competently in our information-based

society. Recognizing that specific skills and knowledges will vary with different jobs, over time and from person to person." (Human Resources Research Organization, Alexandria, Virginia)

" . . . an awareness and understanding of the operational and analytical aspects of computers and their applications and limitations." (NETWORK, New York)

"Be able to define, demonstrate, and/or discuss: How computers are used, How computers do their work, How to use a computer, How computers affect our society." (Kenneth Brumbaugh)[2]

D. H. Watt offers a more specific definition of computer literacy. Watt suggests that computer literacy is comprised of four distinct yer interrelated areas:

1) "the ability to understand the growing economic, social and psychological impact of computers on individuals, on groups within our society, and on society as a whole; and
2) the ability to make use of ideas from the world of computer programming and computer applications as a part of an individual's collection of strategies for information, retrieval, communication and problem-solving; and
3) the ability to use a variety of pre-programmed com-

puter applications in personal, academic, and professional contexts; and

4) the ability to control and program a computer to achieve a variety of personal, academic, and professional goals."[3]

In my experiences working with computers, teachers, and students during the past sixteen years, I have arrived at my own working definition of computer literacy. I believe that the general term computer literacy encompasses two specific areas of skill and knowledge: Computer Awareness and Computer Programming.

Computer Awareness education should cover such topics as principles of computer operation, computer applications, social implications of computer usage, computer-related careers, and the future of computer usage. Generally, Computer Awareness education does not require access to a computer system or, at most, requires only limited access. Instead, Computer Awareness topics lend themselves well to classroom discussion, activities, and projects in virtually every area of the curriculum. Therefore, Computer Awareness can be fostered even in classrooms that do not have computer systems readily available for student use.

In contrast, Computer Programming skills do require a substantial amount of access to computer systems. In the scope

and sequence model presented here, I have suggested that very young students begin by working with programmable devices such as the Big Trak and eventually move on to do Logo, BASIC, and Pilot-type programming. Later, in grades 10 through 12, students are exposed to Pascal as a predominant programming language. Computer Programming education must teach more than programming languages, though. It is essential that along with learning specific languages, students should learn effective methods of planning and designing programs and should understand the uses and limitations of various programming languages.

The emphasis of my approach to computer literacy education is twofold: to provide ideas for the use of the microcomputer as a tool for instruction and to infuse computer awareness into all areas of the traditional curriculum.

Prerequisites for Effective Computer Literacy Education

Regardless of its goals and objectives, a computer literacy education program depends for its success on several factors. The most sophisticated computer hardware and the latest in computer-assisted instruction software will do the student little good unless the overall computer literacy education program has been well planned and implemented from the beginning. Three factors of computer education planning that are particulary crucial are specific statement of goals and objectives, district and local support of computer education, and computer

literacy training for teachers.

In most activities in general and in all educational programs in particular, careful planning always includes clearly defined and stated specific objectives. It is not enough to teach computer literacy with the hope of covering all the topics a student should be familiar with in order to function competently in a computer-oriented society. Those who are responsible for designing computer education programs must set very specific goals for all phases of the program. These goals should map out strategy for support of teachers, allocation of funds for computer hardware and software, and methods of evaluating a program's success. Only after these administrative needs are met does the issue of precisely what will be taught in the computer literacy program become meaningful.

One example of thoughtful computer literacy education planning appears in the District of Columbia Public Schools' Technical Specifications for Hardware and Software, and Maintenance in Support of Computer Literacy Program manual. The district's Computer Literacy Planning Group has developed very specific objectives which it hopes to accomplish within five years of implementing its computer literacy program:

1) to develop computer awareness among students, teachers, supervisors and administrators . . .;
2) to develop and implement a computer literacy curriculm;
3) to develop greater employability skills among students

by expanding programs which prepare them to enter jobs or advanced training for future jobs, particularly those in the D.C. area;

4) to design and implement a Computer Training Laboratory;

5) to apply computer technology in the local school implementation of the Competency-Based Curriculum through drill and practice, tutorials, simulations and other appropriate techniques;

6) to apply computer technology in classroom management, including record-keeping, tracking of student progress and reporting student progress; and

7) to apply computer technology to local school management.[4]

On a more immediate basis, the Computer Literacy Planning Group identifies three goals it hopes to see accomplished within one year of implementing its program:

> The first goal is to provide meaningful exposure to computing topics and devices for as many teaching personnel as possible. . . . The second goal which this Request for Proposals addresses is support for teachers in managing classroom data. . . . The third goal for the first year is to provide supplemental diagnostic and tutorial assistance for certain disadvantaged students via computing.[5]

The setting of specific goals for a computer literacy program not only helps in the process of planning a specific curriculum but also helps to provide a measure by which to judge the suc-

cess of such a program.

District and Local Support of Computer Education

Of course, an essential ingredient of any computer literacy program is the degree of support it receives from the community it seeks to serve. As computers become increasingly pervasive in our society, local support for computer literacy education is bound to increase. Parents understand that their children must be prepared to function comfortably with computers in virtually every facet of their lives. Local employers recognize the need they will have of computer-literate workers in the future and, thus, are likely to support computer literacy education in the schools. Local support can be solicited and enhanced through effective community relations aimed at keeping the local community abreast of the school's position on computer education.

Just as important as local support is district support. Computer literacy education must be an important issue at all levels of administration. Some teachers are frustrated currently with what they perceive as a lack of district support of computer education programs they wish to implement. This can discourage even the most energetic teacher from experimenting with computer literacy in his/her classroom. District support includes allocation of funds for computer literacy programs, in-service workshops and seminars to foster computer literacy among teachers, and ongoing support of programs implemented

by teachers within the district.

Developing Computer-Literate Teachers

One factor that has hampered computer literacy programs is a lack of qualified personnel to conduct them. Recent studies have shown that while most teachers feel a strong need to present computer literacy topics to their students, they also often feel inadequate to do so. This is not surprising given the fact that teachers are educators and should not be expected to be computer scientists as well. Nevertheless, it is essential that teachers receive sufficient training to become competent teachers of computer literacy.

According to Microcomputers for Teachers, any teacher involved in computer literacy education must possess a set of skills that allow the teacher to be effective:

--The teacher should be able to discuss the importance of the computer, citing uses in the home, in business and in education.

--The teacher must comprehend and use terms about microcomputer hardware and software.

--The teacher should know the basic operational scheme of a computer.

--The teacher must know the uses and limitations of microcomputers in the classroom.

--The teacher must be able to operate microcomputer hardware in order to run prepared programs.

--The teacher must find, select, and use microcomputer software.

--The teacher must be able to make informed choices of a microcomputer system's hardware.

--The teacher should be able to read and write simple programs.[6]

These and other computer literacy skills can be taught to teachers in in-service workshops and seminars. In addition, teachers can learn these skills in classes offered at local colleges and universities. Conferences are another excellent source of computer literacy skills for teachers.

Developing a Scope and Sequence

Once a district has gained support for its computer literacy program, has set specific goals and objectives, and has adequately trained its teachers to conduct the program, the next step is curriculum development. Recently the trend in computer literacy curricula has been to introduce students to computers at the earliest date. The work of Seymour Papert and his colleagues has demonstrated that even preschool-age children benefit immensely from early exposure to computers.[7] The primary advantage of early computer education is that very young children have not yet developed "computer-phobia" that may inhibit computer training in later years.

The Scope and Sequence model that I present here takes in

all grade levels from kindergarten through twelfth grade. (See Figure 1.)[8] As mentioned before, the topics and activities included in this Scope and Sequence fall into two categories: Computer Awareness and Computer Programming.[9] The Computer Awareness activities require little or no access to a computer system while the Computer Programming activities require varying degrees of access to computers and programmable devices.

Kindergarten

The child's introduction to computers must begin with a discussion of what the computer is. Ideally the student should be able to describe the computer as a tool or machine that solves problems and helps humans to do their work faster and more accurately. In addition, students need to learn to follow directions, a skill that will aid in future computer training. Students at this level can also begin to establish a vocabulary for talking about computers.

Computer Programming at this level begins with the use of programmable devices, often toys, available on the market. These devices teach children the most fundamental principles of entering commands and seeing the results. Turtle Graphics is another activity that teaches children to enter commands in a predetermined language in order to produce simple shapes.

First Grade

At the first-grade level, the student who already knows what

COMPUTER LITERACY SCOPE AND SEQUENCE

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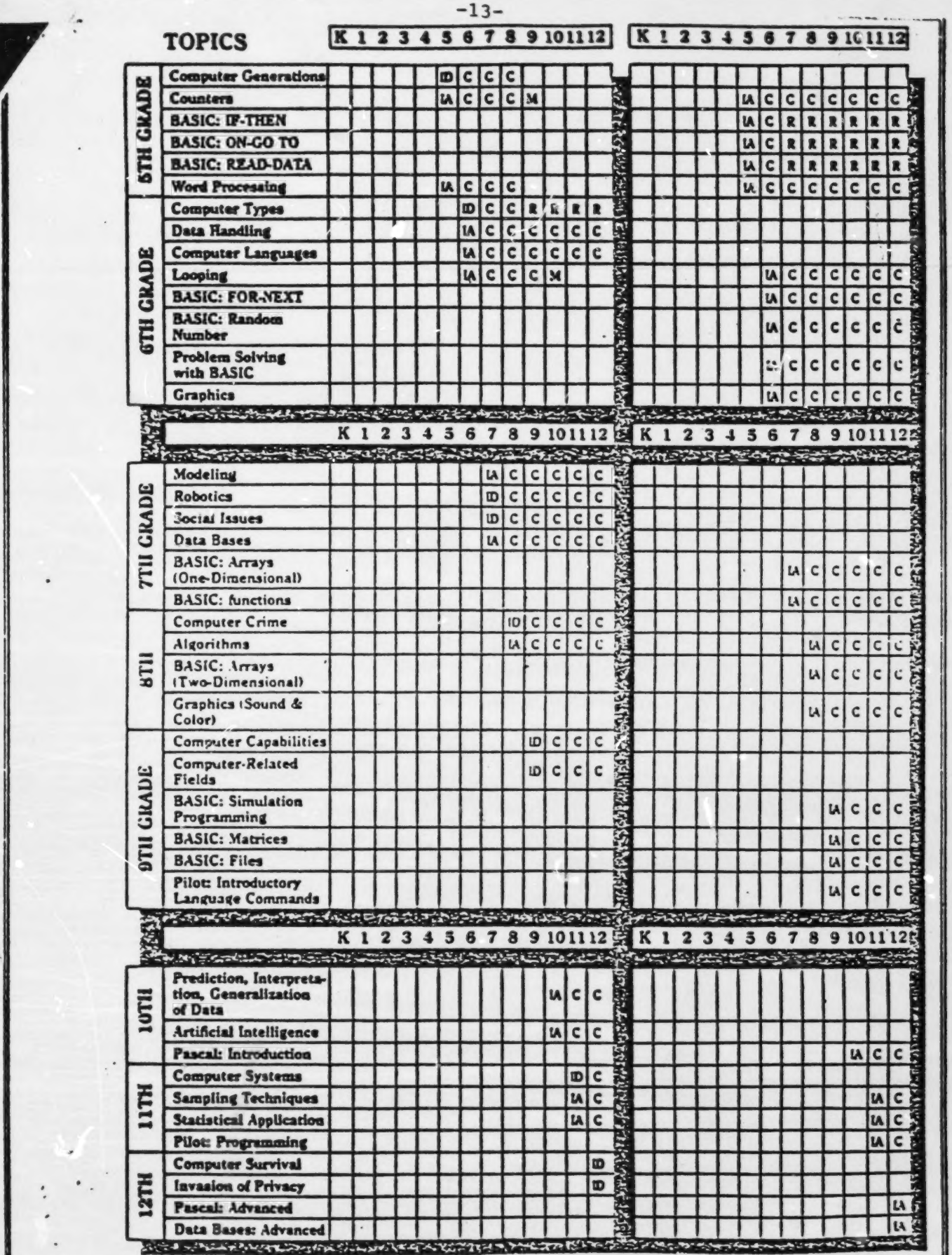
	TOPICS	COMPUTER AWARENESS K	1	2	3	4	5	6	7	8	9	10	11	12	PROGRAMMING K	1	2	3	4	5	6	7	8	9	10	11	12
K	What a Computer Is	IA	C	C	C	C	C	C	C	C	R	R	R	R													
	Following Directions	IA	C	C	C																						
	Vocabulary	IA	C	C	C	C	C	C	C	C	C	C	C	C													
	Programming Programmable Devices														IA	C	M										
	Turtle Graphics (Making Shapes)														IA	C	C										
1ST GRADE	What a Computer Can Do		IA	C	C	C	C	C	C	C	R	R	R	R													
	Learning to Use a Computer		IA	C	C	C	C	C	C	C	C	C	C	C													
	Using the Keyboard		IA	C	C	M																					
	Turtle Graphics (Moving Shapes)															IC	C	C									
2ND GRADE	Computer Advantages			IA	C	C	C	C	C	C	C	C	C	C													
	Computer Disadvantages			IA	C	C	C	C	C	C	C	C	C	C													
	Computers in Our Lives			ID	C	C	C	C	C	C	C	C	C	C													
	Everyday Applications			ID	C	C	C	C	C	C	C	C	C	C													
	Future			ID	C	C	C	C	C	C	C	C	C	C													
	Turtle Graphics (Rotations, etc.)																IA	C	C	C							
	LOGO (Sprites)																IA	C	C	C	C	C	C	C	C	C	C
3RD GRADE	History				ID	C	C	C	C	C																	
	Logic				IA	C	C	C	C	C	C	C	C	C				IA	C	C	C	C	C	C	C	C	C
	How a Computer Works				IA	C	C	C	C	C	C	C	C	C													
	Parts of a Computer				IA	C	C	C	C	C	C	C	C	C													
	LOGO Programming																	IA	C	C	C	C	C	C	C	C	C
	Problem Solving with LOGO																	IA	C	C	C	C	C	C	C	C	C
		K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
4TH GRADE	Hardware					ID	C	C	C	C	C	C	C	C													
	Software					ID	C	C	C	C	C	C	C	C													
	Flowcharting					IA	C	C	C	C	R	R	R	R					IA	C	C	C	C	C	C	C	C
	Storyboarding					IA	C	C	C	C	R	R	R	R					IA	C	C	C	C	C	C	C	C
	BASIC: PRINT & REM																		IA	C	C	C	C	R	R	R	R
	BASIC: LET																		IA	C	C	R	R	R	R	R	R
	BASIC: INPUT																		IA	C	R	R	R	R	R	R	R
	BASIC: GO TO																		IA	C	R	R	R	R	R	R	R
	Formulas (Variables & Constants)					IA	C	C	C	C	C	C	C	C					IA	C	C	C	C	C	M		
	String Data																		IA	C	C	C	C	C	C	R	R
	Relations					IA	C	C	C	M									IA	C	C	C	M				
	Binary Numbers					IA	C	C	C	C	C	C	C	C													

LEGEND

- IA—Introduction with Activities
- ID—Introductory Discussion
- C—Expansion of Discussion from Previous Grades
- R—Review
- M—Mastery

Editor's Note: This Scope and Sequence Chart can be read in two ways. If you're a third grade teacher, and you want to find out what topics the author suggests that you introduce to your students, refer to the "Third Grade" section on the left hand side of the chart. To find out what topics you should plan to introduce, drop or reinforce, look [illegible]


TOPICS
K 1 2 3 4 5 6 7 8 9 10 11 12
5TH GRADE
Computer Generations
Counters
BASIC: IF-THEN
BASIC: ON-GO TO
BASIC: READ-DATA
Word Processing
6TH GRADE
Computer Types
Data Handling
Computer Languages
Looping
BASIC: FOR-NEXT
BASIC: Random Number
Problem Solving with BASIC
Graphics
7TH GRADE
Modeling
Robotics
Social Issues
Data Bases
BASIC: Arrays (One-Dimensional)
BASIC: functions
8TH
Computer Crime
Algorithms
BASIC: Arrays (Two-Dimensional)
Graphics (Sound & Color)
9TH GRADE
Computer Capabilities
Computer-Related Fields
BASIC: Simulation Programming
BASIC: Matrices
BASIC: Files
Pilot: Introductory Language Commands
10TH
Prediction, Interpretation, Generalization of Data
Artificial Intelligence
Pascal: Introduction
11TH
Computer Systems
Sampling Techniques
Statistical Application
Pilot: Programming
12TH
Computer Survival
Invasion of Privacy
Pascal: Advanced
Data Bases: Advanced

a computer is begins to develop an appreciation for what a computer can do. At this level, students can also begin to learn to use the computer by loading and running preprogrammed software on the computer. Students should also begin to learn the numbers, letters and symbols on a microcomputer keyboard.

Computer Programming at this level continues the use of Turtle Graphics. Now, however, students learn not only to create shapes of increasing complexity but also to move these shapes horizontally and vertically on the screen.

Second Grade

Second-grade students are ready to discover the advantages that computers offer users. Among these advantages are speed, accuracy, and the ability to perform repetitious activity. Along with this, students should be exposed to the disadvantages of computer usage. This means that the student will come to understand that the computer is impersonal and literal (i.e., that it is not capable of distinguishing between correct and incorrect information, moral or immoral activity, etc.). The student can also begin to appreciate many roles that the computer plays in our lives today. This will include identifying common applications of computers that students find commonly around them.

Computer Programming at this level continues the use of Turtle Graphics with students developing the capability to

rotate shapes to create a variety of designs. Also the student will work with Logo sprites to create and control sprites as well as giving them color, speed, and direction.

Third Grade

Students at the third-grade level should learn about the history of computer development and be able to discuss several forerunners of the contemporary computer. Students should also begin to comprehend simple logical "and" and "or" statements. In addition, students can learn the basics of computer operation, including Input, Memory, the Central Processing Unit, the Arithmetic Unit, and Output. Along with this understanding of how a computer works, the student will learn about different parts of a computer.

Computer Programming at this level focuses on Logo in two specific activities. The student should combine the ideas of turtle geometry and sprites, thereby creating animation and sequential graphic display. Also, the student should learn to use Logo to solve problems that relate to various areas of the curriculum.

Fourth Grade

Fourth-grade students can become thoroughly familiar with the term hardware, describing it as the physical components of a computer system. Additionally, students will learn to define the term software as a set of instructions, often referred to

as a program, that tells a computer what to do. Binary numbers can be introduced at this point, and students should discover how the computer uses 0 and 1 to represent letters, numbers and symbols. Students should be exposed to the process of flow charting by learning the common flow chart symbols. They should also be able to develop a short picture program and prepare a storyboard for each display.

Computer Programming at this level introduces the fourth-grader to the BASIC language. Students should become familiar with PRINT, REMARK, LET, INPUT and GOTO statements by using the statements in simple programs. Students should also be able to write formulas in BASIC including variables and constants. Basic concepts of string data can be fostered at this grade level. Finally, students should be made aware of the relations: less than and greater than.

Fifth Grade

Fifth-graders ought to be given an in-depth understanding of the different generations of computers so that they can differentiate among vacuum-tube, transistor, and integrated circuit technology. Also students need to learn the basic concept of the counter.

Computer Programming at this level builds on previously gained knowledge of programming in BASIC with the student learning IF-THEN, ON-GOTO, READ-DATA statements and fundamentals of

word processing.

Sixth Grade

Sixth-graders are prepared to learn the differences among mainframes, minicomputers, and microcomputers. Also, students should learn about the use of computers to process data. Different computer languages and their applications can be presented at this point. Students can also be introduced to the process of looping.

Computer Programming at this level further enhances the student's grasp of BASIC, including the FOR-NEXT and RANDOM statements.

Seventh Grade

At this level, students can do modeling to develop a specific plan to solve general problems. Students should also be exposed to robotics and some of the numerous social issues raised by computer usage. The fundamentals of data base use can be explored at this time.

Computer Programming at this level continues to concentrate on the BASIC language. Students may utilize one-dimensional arrays in BASIC programs and use BASIC statements to define functions.

Eighth Grade

Eighth-graders may want to explore the broad topic of com-

puter crime. This is also an appropriate time to introduce students to algorithms and their uses.

Computer Programming at this level stresses two-dimensional arrays in BASIC programs. Students will also incorporate sound and color into a computer program.

Ninth Grade

Students at this grade level should be prepared to discuss general computer capabilities. This is also an excellent time to present information on computer-related careers as students begin planning for vocations.

Computer Programming at this level includes writing a simulation program as well as using the BASIC matrix command to solve problems in BASIC programs.

Tenth Grade

Tenth-graders can write programs to collect and organize data and interpret, predict, or generalize output. Students should also be exposed to the concept of artificial intelligence and some of its potential applications.

Computer Programming at this level includes the introduction of the Pascal language. Students should be able to write a simple program in Pascal at the conclusion of this term.

Eleventh Grade

At this point, students should investigate various computer systems and be able to point out the strong and weak points of different types and brands of computers. They should also learn to set up a sampling technique for making decisions or predictions. This activity will lead to using the computer to perform statistical computations.

Computer Programming at this level introduces the student to the use of authoring languages such as PILOT to write computer programs.

Twelfth Grade

In the final year of a computer literacy program, students should be equipped with computer survival skills, that is, an understanding of the impact that computers are likely to have on our society in the future. Another extremely topic to explore at this point is protecting individual privacy in the Information Age ahead.

Computer Programming at this level will further the student's knowledge of Pascal. In addition, students should learn to outline the procedure to prepare, access, and update data bases.

Conclusion

Regardless of the specific content of a scope and sequence

developed for computer literacy education, the curriculum should stress two major areas: Computer Awareness and Computer Programming. Computer literacy education can be successfully accomplished at all grade levels as long as objectives are clearly defined and stated, the program is supported strongly by the local community and school district as a whole, and teachers are given the preparation they need to foster the skills their students will need to flourish in the Age of Computers.

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